NUCLEAR WASTE – WHAT TO DO WITH IT ?

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(This talk was delivered by Bruce McKirdy as Mr Waite was unwell)

INTRODUCTION

The Nuclear Decommissioning Authority (NDA) is a non-departmental public body, established under the Energy Act 2004. We are responsible for the decommissioning and clean-up of the UK's civil public sector nuclear sites. The NDA's arrival signalled perhaps the greatest change in the UK nuclear industry since its formation. It is the first time a single organisation has been responsible for managing the decommissioning, clean-up and disposal process across the country.

The NDA's mission is:

to deliver safe, sustainable and publicly acceptable solutions to the challenge of nuclear clean-up and waste management. This means never compromising on safety, or security, taking full account of our social and environmental responsibilities, always seeking value for money for the tax payer, and actively engaging with stakeholders.

. . . it is unacceptable to postpone final disposal to future generations . . .

The Energy Act 2004 gave us specific duties including securing the treatment, storage, transportation and disposal of legacy wastes and development of a strategy for carrying out these functions. In addition the Government's Low Level Waste (LLW) Policy Review (published 2007) made it clear that the NDA was responsible for implementation of the new LLW policy and for the operation and competition of existing LLW facilities.

The Government's Managing Radioactive Waste Safely (MRWS) White Paper was published in June 2008 [1]. It sets out the policy for higher-activity wastes as geological disposal preceded by safe, secure storage, supported by R&D. It also gave responsibility to the NDA for planning and implementation of geological disposal.

RADIOACTIVE WASTE

Radioactive waste is divided into three main categories according to how much radioactivity it contains and the heat that it generates:

- Low Level Waste (LLW)
- Intermediate Level Waste (ILW)
- High Level Waste (HLW)

There are also some radioactive materials that are not currently classified as waste, but that may need to be managed through geological disposal. These include:

- Spent fuel
- Plutonium
- Uranium

We use a hierarchical approach to minimise the amounts of waste requiring disposal. The hierarchy consists of avoiding waste generation where practicable; minimisation of arisings where the creation of waste is unavoidable; recycling and reuse; and only then disposal.

The Government reviewed the LLW Policy in 2007. In this it made it clear that diversified disposal solutions based on a risk-based approach are preferred and that the NDA has responsibilities for its implementation. The review also outlined the international waste transfer rules. It made clear that it is unacceptable to postpone final disposal to future generations and committed the NDA to develop a strategy by the end of 2009.

A 'Baseline Inventory' of higher activity wastes for geological disposal is given in the MRWS White Paper. This includes the total amounts of radioactive wastes and other materials that could require geological disposal in the future. However, these figures are calculated on a number of assumptions and can only be taken as indicative because waste amounts will change over time.

Interim stores can provide safe and secure protection for waste packages for a period of 50-100 years. However, the higher activity wastes are potentially hazardous for hundreds of thousands of years.

Rather than leave these wastes in interim stores, we have a responsibility to deal with them as soon as is practicable. In this way we will remove the burden imposed by our actions on future generations. It also provides an end-point for decommissioning and clean up of existing sites.

MANAGING RADIOACTIVE WASTE SAFELY (MRWS) PROGRAMME

In 2001 the UK Government and devolved administrations initiated the Managing Radioactive Waste Safely (MRWS) programme with the aim of finding a practicable solution for the UK's higher activity wastes that:

- achieved long-term protection of people and the environment
- did this in an open and transparent way that inspired public confidence
- was based on sound science
- ensured the effective use of public monies.

In October 2006 the UK Government and devolved administrations accepted the Committee on Radioactive Waste Management's recommendations that geological disposal, preceded by safe and secure interim storage, was the best available approach for the long-term management of higher activity radioactive wastes.

Following a consultation, Government published in June 2008 the MRWS White Paper: A Framework for Implementing Geological Disposal. This covers:

- Government's framework for managing higher activity radioactive waste through geological disposal
- Indicates how the issues of safe and secure interim storage and R&D are being addressed
- Invites communities to open without commitment discussions with Government about possible future hosting of a geological disposal facility

A number of countries (including Finland and Sweden) are already investigating their preferred sites for a geological disposal facility for spent fuel. Finland and Sweden already have shallow geological facilities for disposal of ILW and LLW. Sweden has been operating the deep geological research facility, testing techniques for disposal of spent fuel, for a number of years. France is investigating a site at Bure with a view to it becoming the final disposal facility and Canada is developing a deep repository for LLW and ILW at Kincardine.

There are a number of key issues that arise from this experience, including:

- All counties who have developed a policy for long term management of radioactive waste are pursuing geological disposal
- Need a voluntarism approach, not adversarial
- Processes must be open and transparent
- Need secure long-term funding
- Need to maintain momentum, but can only work at the speed stakeholders are comfortable with

It will take a number of years before a geological disposal facility is able to accept waste. In the meantime we must continue to have safe and secure interim stores, typically for periods of up to 100 years.

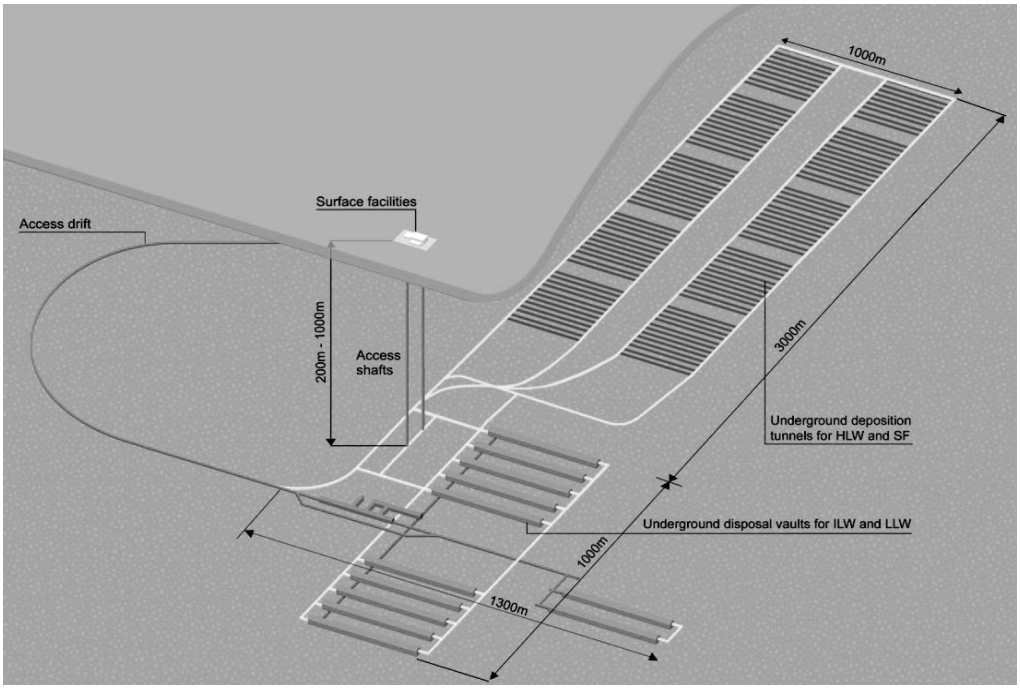
As part of our work we are running a national review of the adequacy of ILW storage. We are also investigating opportunities for rationalising waste storage ie reducing the number of stores that are required.

Geological disposal involves isolating radioactive waste deep inside a suitable rock formation to ensure that no harmful quantities of radioactivity ever reach the surface environment (see diagram below). It is a multi-barrier approach, based on placing wastes deep underground, protected from disruption by man-made or natural events. Geological disposal is internationally recognised as the preferred approach for the long-term management of higher activity radioactive waste.

As noted earlier, the UK Government policy is aligned with countries such as Finland, France, Sweden and the USA who have already made good progress towards implementing geological disposal. The UK is therefore well-placed to benefit from international experience in this field, while using and maintaining domestic capabilities.

The MRWS White Paper sets out the roles and responsibilities for those parties involved in the implementation of geological disposal as follows:

- **Government** is responsible for the policy, will take final decisions and engage with stakeholders to ensure that the objectives of the MRWS programme are met



- **The NDA** is the implementing organisation, responsible for planning and delivering the geological disposal facility and, as part of this process, will engage with communities and other stakeholders.
- **Communities** with a potential interest in hosting a geological disposal facility will have the opportunity to work with the NDA and others in a partnership approach during the process.
- **Local government** will be fully engaged in a partnership approach and will play a part in local decision-making during the site selection process.
- **Independent regulators** will ensure robust, independent regulation in relation to statutory responsibilities for ensuring that national, EU and international safety, security and environmental legislation and standards are met.
- **Committee on Radioactive Waste Management (CoRWM)** will provide independent scrutiny and advice to Government on the plans and programmes for delivering geological disposal including interim storage.

NEXT STEPS

The Government continues with the siting process for a geological disposal facility based on a voluntarism and partnership approach. So far one Borough Council has formally expressed an interest and another is consulting with its community. Additionally a County Council is also consulting with its stakeholders.

We look forward to working in partnership with whichever potential host communities come forward.

We want a range of stakeholder inputs and are consulting on a range of subjects including:

- proposed R&D Strategy for geological disposal
- proposed frameworks for public and stakeholder engagement & Sustainability and Environmental Assessment
- strategic issues e.g. Plutonium

Reference:

1 Managing Radioactive Waste Safely: A framework for implementing geological disposal, June 2008. A White Paper by Defra, BERR and the devolved administrations for Wales and Northern Ireland

NUCLEAR WASTE – WHAT TO DO WITH IT?

NUCLEAR WASTE AND THE NNL

Dr Peter Bleasdale
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Managing nuclear waste in the safest, most effective manner possible is a key challenge for the nuclear industry. Alongside its commitment to clean up the UK's civil nuclear legacy, Government has also given its backing for nuclear to play a key role in helping the UK achieve its energy goals of tackling climate change and securing the UK's future energy needs.

The new National Nuclear Laboratory for the UK is an international centre of excellence in nuclear research and development, playing a vital role in cleaning up the UK's nuclear waste legacy and contributing to nuclear new build. The NNL safeguards the UK's nuclear expertise, facilities and skills.

All industrial processes produce wastes and the NNL has played a key role in the management of waste produced by the nuclear industry. The industry has made a strong effort to build trust as a safe, profitable, technology led business with little impact on the environment. Huge strides have been made since the 1980s in managing wastes.

. . . The cementation technology has been so successful that it has been sold overseas to Japan and the USA. . . .

Over the years, the NNL has provided support in resolving many of the waste management and disposal challenges presented to the industry. These include wastes currently being produced from reactor operations and reprocessing. The NNL has also worked on the waste legacy produced in the past through civil and military programmes. This includes supporting retrieval of raw wastes, conditioning, packaging and interim storage. Further work will ensure waste products meet disposal requirements in the future.

Government has accepted that deep geological disposal is the most appropriate option for higher activity waste. This means

placing it underground in stable rock structures. The Nuclear Decommissioning Authority (NDA) has the job of finding a suitable site. The NNL will support the NDA by applying science and innovation at the right levels.

Wastes are classified into High, Intermediate and Low level streams. High-level waste (HLW) is very radioactive and generates heat. This waste is what remains when used nuclear fuel has been reprocessed to produce reusable products. Intermediate-level waste (ILW) is far less radioactive and is made up of items such as fuel element cladding, contaminated equipment and sludge produced from treatment processes. Low-level waste (LLW) includes paper towels, clothing and laboratory equipment used in areas where radioactive materials are deployed.

LEGACY WASTE

Nuclear operation in the UK began over five decades ago. Early operations at Sellafield saw large amounts of waste produced and stored in raw form in various silos, storage ponds and other facilities. These wastes include plutonium contaminated materials and high activity liquid wastes that need to be retrieved, conditioned, immobilised, packaged and stored safely.

The ways in which wastes are packaged is very important as products have to be acceptable for long-term future storage and deep geological disposal. The NNL has carried out extensive technical work in support of these operations.

There are many examples where this work has made a significant contribution. For instance, the work carried out by the NNL in supporting sludge tank retrievals at Sellafield. The Sellafield sludge tanks were last used in the 1970s and still contain significant quantities of radioactive sludge. The challenge was to develop long-term storage solutions for the waste in a safe manner using technologies that offer minimum costs to the tax payer.

The accepted route for storing sludge is to mix with cement in a storage drum. This method results in a solid waste form. Fewer drums lead to lower storage costs. The NNL solution adjusted cement chemistry to increase the concentration of waste put in the drum by a factor of two. This means that the number of drums produced is potentially halved from an initial 12,000 to 6,000. The time required to process wastes is also halved. The approved new waste form is being implemented.

Also at Sellafield, there is a quantity of plutonium residues which are not suitable for recycling and need to be managed. The NNL challenge was to find a safe long-term immobilisation and encapsulation technique for the material. The NNL worked with the Australian Nuclear Science and Technology Organisation to modify an existing process for generating a ceramic waste form.

This work has been so successful that it has been named as a preferred waste management technology for these residues. The intention is to incorporate the waste into the ceramic matrix prior to storage and disposal.

WASTE FROM CURRENT OPERATIONS

As operations continue, the NNL provides support in each of the three main waste categories. For low level solid wastes, technology solutions are provided to the LLW repository located a few miles south of Sellafield. The NNL has been carrying out technical support for the operating safety cases, building on work already carried out to produce a post closure safety case for the facility.

Understanding Post Closure scenarios helps underpin the ultimate case for closing the site far into the future. This was the first safety case of its kind in the world produced for a low level waste facility. Other work includes helping to minimise waste production in the first place and improvements in processing methods such as enhanced immobilisation.

The NNL provides technology to assist in the handling of intermediate level wastes, particularly at Sellafield. The Lab supports continued and improved operations in effluent plants. For example, the Enhanced Actinide Removal Plant (EARP) at Sellafield uses ultra filtration to separate out radioactive elements from effluents produced on site. The NNL analyses the operation of the plant in great detail and advises customers on the best way to improve efficiencies and maintenance and make sure EARP continues to play a key role in effluent management at Sellafield.

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The ILW encapsulation processes underpin the storage of treated materials at Sellafield. The Magnox Encapsulation Plant (MEP) and Waste Encapsulation Plant (WEP) are the first ever commercial scale cementation plants worldwide for this type of waste. The NNL played a key role in their development and operation and is proud of its contribution to plants that continue to operate efficiently. The cementation technology has been so successful that it has been sold overseas to Japan and the USA. With ILW, stable products are being produced that are suitable for storage and eventual deep disposal. At Sellafield, all ILW produced during operations is processed for storage and disposal as it arises.

High level waste is the most radioactive material stored at Sellafield. NNL has developed processes used to treat HLW and the NNL now supports operators in various ways to manage the waste. HLW is stored in tanks at Sellafield in controlled conditions. Tanks are being progressively emptied and the waste converted into a glass based product using a process called vitrification in a dedicated facility – the Waste Vitrification Plant (WVP).

NNL has worked extensively on the vitrification process to refine and improve performance. WVP is vital to Sellafield as it also deals with new waste being produced as a result of used fuel reprocessing operations. A full-scale replica of the vitrification plant is operated by NNL to make sure WVP remains as efficient as possible. Over the past few years we have improved process throughput by over a third to enable the waste to be treated a number of years earlier than originally planned. The NNL undertakes work to make sure the liquid waste evaporators and storage tanks are functioning at their optimum level.

Eventually, all high level waste stored at Sellafield will be converted into glass product, a very stable waste form readily capable of being stored safely. Now that wastes are being successfully immobilised and packaged into a stable form via processes such as encapsulation and vitrification, the NNL is advancing studies to assess how wastes will behave in a deep geological facility.

DISPOSAL

The Radioactive Waste Management Directorate (RWMD) has been launched by the NDA to develop repository strategy and design. NNL work in support of RWMD is an area where a real and sustained contribution can be made. A number of projects and activities are already under way. A series of trials have been set up to monitor corrosion and expansion of cemented Magnox waste under repository conditions.

NNL has a depth of experience of how these wastes behave in current interim storage above ground and this knowledge is being applied to study waste behaviour in a deep underground facility. NNL will constantly improve understanding of wastes, how to deal with them, make them safe for storage and finally make them good for permanent disposal.

SUMMARY

The NNL is an experienced and capable provider of integrated nuclear solutions and the leading supplier of technology services to the UK nuclear market. It employs the best people and will develop through the application of tailored innovation. NNL strives to become the international centre of excellence in nuclear research and development and play the key role in cleaning up the UK's nuclear waste legacy. The Lab will contribute to nuclear new build and safeguard and grow high-tech nuclear expertise, facilities and skills.

We have been presented with a great opportunity to underpin technical innovation and create a National Nuclear Laboratory that the UK can be proud of.

DURING DISCUSSION THE FOLLOWING POINTS WERE RAISED

How are we reacting to the great loss of skills in the nuclear industry? Universities are now making great efforts to recoup the losses of professional staff with help from the industry. However, young people need to be influenced very early in their choice of career. The industry works with several organisations; one example is the Smallpiece Trust which runs one week courses in vacations for 14-16 year olds. The most recent course attracted 200 applicants for 70 vacancies. We could do more and we also work with 10 year olds in schools where the emphasis is on science. A lifeline plan has been prepared to help develop the skills required by the industry, in schools and universities which will be rolled out on 4 November in Manchester.

There may also be a need, in addition to reprocessing, for direct disposal of nuclear waste from the new generation of nuclear reactors which is addressed in the Nuclear Energy White Paper. If nuclear waste is likely to be required for reprocessing, it would not be disposed of in the first place. However the option for retrievability is maintained within the overall plan for waste management and all the equipment used can be safely recovered. For example the 105t Pu stored at Sellafield is subject to the decision as to whether it is a waste or an asset. There is also a complete mock-up of a MOX facility available at Sellafield should the decision be taken subsequently to reuse the Pu in such a facility to make MOX nuclear fuel rather than dispose of it as waste. The technology is well understood, however the present mechanical design of the facility, which is a sequential process lacking any built-in redundancy, is therefore vulnerable to unplanned plant closure.

Deep geological disposal of High and Intermediate Level Waste had been recommended 40 years earlier and suitable sites were identified as a result of a geotechnical assessment of the UK conducted by the Government. This was presented as a geotechnical solution to the problem at that time, which unfortunately could not be implemented due to a lack of adequate local consultation of the people most likely to be affected, unlike Sweden and Finland where local communities were consulted extensively. The present arrangement for disposal in the UK is based on a non-adversarial procedure involving local communities.

THORP was developed and started work in 1993. It is a flexible facility supported by research R&D undertaken by a skilled workforce. It can be used for re-processing waste from Light Water Reactors and can also accept high burn-up MOX fuel for re-processing. This technology is also of commercial and scientific interest to the US. Sellafield staff are also working with a EU consortium developing new processing technologies. However, a new plant would probably be required to recover Pu for use in MOX fuel from the existing resource of Pu enriched waste due to lack of capacity in existing plant. The recently appointed managing contractor for Sellafield now involves a French component and the NNL is also equipped and prepared to undertake this work should Government decide to recover the Pu rather than dispose of it as waste without further reprocessing.

With regard to EU oversight on nuclear waste disposal, the site selected for deep geological disposal has to be safe enough. It does not have to be the safest site. There are many other criteria involved in the site selection procedure. Waste degradation, including microbial degradation has been recognised and will need to be considered as part of the overall waste disposal strategy. It was suggested that the nuclear industry had previously 'run out of trust'. Are there any aspects of the industry where they currently lack relevant information? If there are any such areas of uncertainty these should be shared with the public. What are the advantages, if any, of disposal in 5km deep boreholes relative to disposal at less than 1km? There are many questions requiring answers. We do not know waste behaviour in the long term, requiring a research programme to be undertaken to identify the waste forms involved. This will help to optimise the waste disposal procedure by excluding any problematic wastes from deep disposal sites. However there are no uncertainties we are aware of with the potential to halt the overall procedure of deep geological disposal. Deep geological disposal in boreholes is conceptually sound but the practical difficulty of drilling holes of adequate diameter and inserting the waste presents problems, however a watching brief is maintained on this aspect. HLW though active and relatively stable is initially heat generating and is currently retained in engineered storage and cooled by air convection heated to 140°C. ILW is less active and less stable and gives off gas.